Vectors & Navigation Problems

September 27, 2017 12:54 PM

Terms used:

* $\vec{\text{heading}}$ * aiming * still water * with respect to air or water * airspeed	+	* $\vec{\text{wind}}$ or * current	=	* $\vec{\text{resultant}}$ * relative to ground or shore * actual path * track

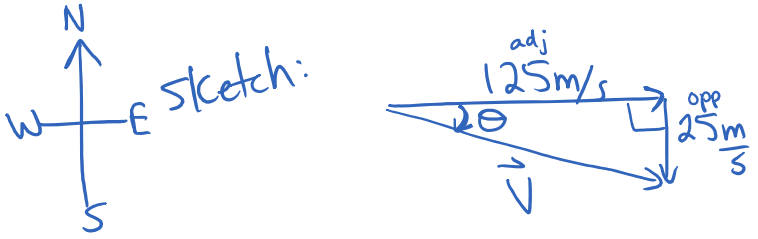
↑ always connects tail of 1st to head of last.

Ex A plane is heading East at 125 m/s with a wind blowing S at 25 m/s. What is the ground-speed and resulting direction?

equation: heading + wind = groundspeed

$125\frac{m}{s}[E] + 25\frac{m}{s}[S] = \vec{V}$

sketch:

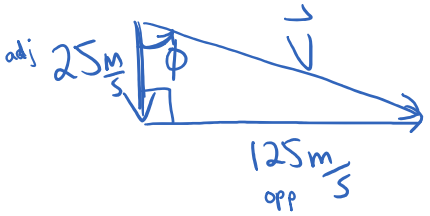


"angle from tail of resultant"

$\tan\theta = \frac{25}{125}$

$\theta = [11° \text{ S of E}]$ ← same answer

or



$\tan\phi = \frac{125}{25}$

$\phi = [79° \text{ E of S}]$

pythag. $V = \sqrt{25^2 + 125^2}$

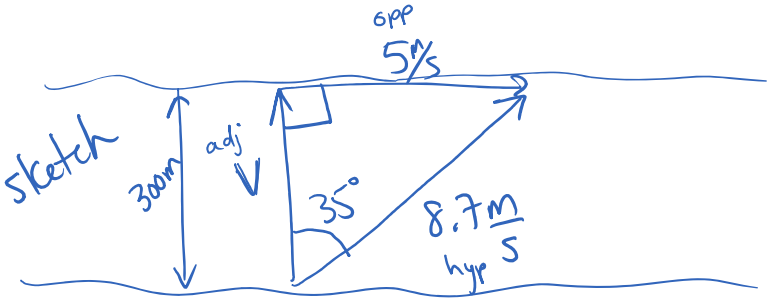
$= 127 \frac{m}{s}$

Ans: $127 \frac{m}{s}$ [11° S of E) or $127 \frac{m}{s}$ [79° E of S]

Ex A boat aims to travel directly N across a river, but there is a $5 \frac{m}{s}$ current to the East causing the boat to travel $8.7 \frac{m}{s}$ [35° E of N]. What is the boat's velocity w.r.t. the water?

equation

aims [N]	+	current	=	result
V		$5 \frac{m}{s}$ [E]		$8.7 \frac{m}{s}$ [35° E of N]



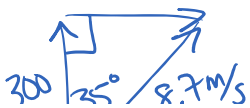
Calculate $\tan 35° = \frac{5}{V}$ or $\cos 35° = \frac{V}{8.7}$

$V = \frac{5}{\tan 35°} = 7.1 \frac{m}{s}$ $V = 8.7 \cos 35 = 7.1 \frac{m}{s}$

Calculate the time to cross if river is 300m wide.

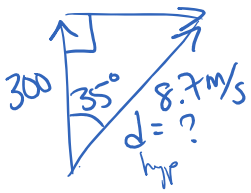
$V = \frac{d}{t}$ $t = \frac{d}{V} = \frac{300m}{7.1 \frac{m}{s}} = 42s$

Or



$\cos 35° = \frac{300}{d}$

Or



$\cos 35° = \frac{300}{d}$

$d = 366.23m$

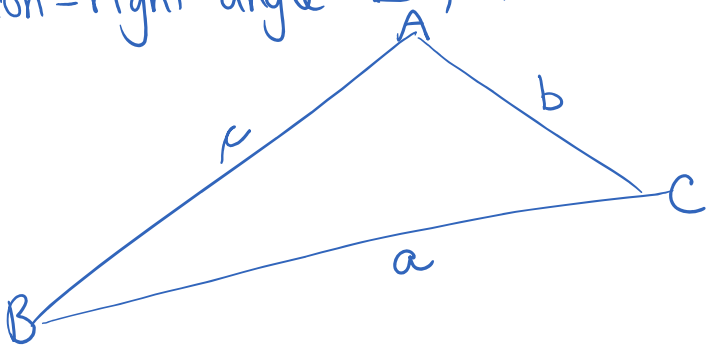
$t = \frac{d}{v} = \frac{366.23m}{8.7 m/s} = 42s$

How far down stream did the boat float?

$d = vt$

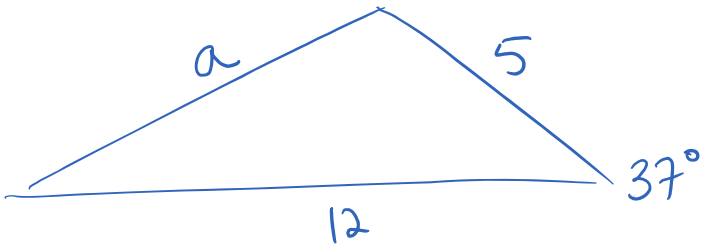
$= \left(5\frac{m}{s}\right)(42s) = 210m$

If non-right angle Δ, then use



Sine Law: $\frac{\sin A}{a} = \frac{\sin B}{b}$ or $\frac{a}{\sin A} = \frac{c}{\sin C}$

Cosine Law: $a^2 = b^2 + c^2 - 2bc\cos A$



$a^2 = 5^2 + 12^2 - 2(5)(12)\cos 37°$